WINTER PREFERENCE, NUTRITIVE VALUE, AND OTHER RANGE USE CHARACTERISTICS OF *KOCHIA PROSTRATA* (L.) SCHRAD

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ABSTRACT. — A cafeteria-style study was conducted during the winter for two years with tame mule deer to determine if there were preferential differences between accessions of forage kochia (*Kochia prostrata*). Deer consumed significantly more of P.I. numbers 314929, 330708, and 356826 than any of the other accessions. Other plant adaptive characteristics and nutritive qualities are also reported.

Forage kochia or perennial summer cypress (*Kochia prostrata*) is a widely distributed shrub native to the arid and semiarid regions of southern Europe and from northern Africa to Manchuria (Moghaddam 1978). Forage kochia was first introduced into the United States from Russia during the early 1960s (Keller and Bleak 1974). In its native Russia, it is commonly associated with *Agropyron*, especially crested wheatgrass (*A. cristatum*) (Balyan 1972).

There is an increasing interest in forage kochia as a desirable half-shrub for revegetation work on many arid and semiarid western ranges.

Ecotypic variation has been noted by many researchers (Balyan 1972, Francois 1976, Keller and Bleak 1974, McArthur and others 1974). Chromosome work indicates that the accessions we worked with included diploids, tetraploids, and hexaploids. The P.I. number 314929 was a diploid (McArthur 1984, personal communication). This same accession has recently been released as "Immigrant" forage kochia for forage and erosion control on greasewood-shadscale, sagebrush-grass, and pinyon-juniper rangelands of the Intermountain West (Stevens et al., in press).

Differential preference of wintering mule deer among accessions of big sagebrush (*Artemisia tridentata*) and black sagebrush (*A. nova*) has been reported by Welch et al. (1981). Also, Van Epps and McKell (1978) reported differential preference of domestic sheep for accessions of fourwing saltbush (*Atriplex canescens*).

The purpose of this study was twofold: first to determine the preference of tame mule deer for 13 accessions of *K. prostrata* grown in a uniform garden, and second to report the results of research concerned with the nutritive value and use of *K. prostrata*.

METHODS

Four tame mule deer (one buck and three doe) were used in a cafeteria-style preference study for two winters, 1978 and 1979. The second year, three of the four deer were the same as the first year. Throughout the study, the deer were given free choice of their specially formulated and pelleted feed, alfalfa hay, rolled barley, and water.

Selected accessions of forage kochia (Table 1) were air dried and clipped into 6 to 10 cm lengths. Samples were randomly assigned to 1 gal plastic buckets placed in a row in a rack in the deer pen. After 24 hours, each bucket was weighed and refilled with 120 g of clipped forage and again randomly placed in the rack. The test ran for 10 consecutive days each winter.

Analysis of variance was used to determine if there were significant differences between treatment means. Newman-Keuls multiple means test was used to determine the significant differences between individual means.

RESULTS

Deer consumed significantly more of some accessions than others (Table 1). Deer pre-

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TABLE 1. Deer preference for selected accessions of *Kochia prostrata*, plant introduction numbers, soil types, and origin of *K. prostrata* accessions used in this study.

Grams/day	P.I. number	Soil type	Location
53.9[a]*	314929	**	Stavropol, Russia
43.4[a]	330708	**	Tehran, Iran
39.4[a]	356826	Salty	Actobinsk, Ural Mountains, Russia
13.3[b]	**	**	Yun Dudar, Russia
13.2[b]	356818	Clay	Actobinsk, Aral Sea, Russia
12.8[b]	356819	Salty	Actobinsk, Aral Sea, Russia
8.6[b]	356823	Sandy	Actobinsk, Russia
6.8[b]	356822	Clay	Ural Mountains, Russia
3.4[b]	356825	Clay	Actobinsk, Russia
2.8[b]	356820	Sandy	Actobinsk, Aral Sea, Russia
0.9[b]	356817	Salty	Actobinsk, Aral Sea, Russia
0.9[b]	356824	Salty	Actobinsk, Russia
0.1[b]	356821	Salty	Actobinsk, Aral Sea, Russia

*Values sharing the same letter superscript are not significantly different at the 95% level.
**Information not available.

ferred P.I. numbers 314929, 330708, and 356826 over the other 10 accessions. These 3 accessions did not differ significantly. The less preferred group of 10 accessions also failed to show significant differences in their means. It should be noted that P.I. numbers 356817, 356824, and 356821 received less than a gram of use per day. Data indicate that preference by tame mule deer for accessions of forage kochia is highly variable. We have no reason to believe that preference of wild and tame mule deer for accessions of *Kochia* differs significantly (Wallmo and Neff 1970). Highly preferred accessions (P.I. 314929, P.I. 330708, and P.I. 356826) are the ones that should be used in reseeding efforts where grazing is one of the management objectives.

DISCUSSION

Because of great ecotypic variation, forage kochia appears to be a useful range plant for improvement of our semiarid ranges. Some forage kochia ecotypes are quite salt tolerant. Francois (1976) tested two accessions for three years and found both to be salt tolerant, but one was significantly more productive at all salinity levels. The highest salinity level was twice that normally found in a greasewood community (Gates et al. 1956).

Forage kochia is drought tolerant. Moghaddam (1978) describes transplanting it into areas of Iran where annual precipitation was only 150 mm. He further reported that forage kochia's productivity and persistence was superior to fourwing saltbush. In Russia forage kochia is cut as "cypress hay" and fed to sheep, goats, and horses in regions having as little as 165 mm annual precipitation (Balyan 1972).

The nutritive value of forage kochia has received some attention. Davis (1979) reported that the oxalate—a potential animal poison—level in forage kochia was lower than levels in fourwing saltbush and winterfat (*Ceratoides lanata*). Welch and Davis (1984) reported the mean in vitro digestibility of the 13 accessions used in this study was 32.2% of dry matter (Table 2). In comparison to other winter forages, forage kochia ranks low in digestibility. Seasonal crude protein content was also determined for the accessions of forage kochia (Table 3). Mean crude protein was highest during July (14.4%) and November (10.7%) for "upper" stems. For the "lower" stems, highest mean protein was May (12.8%) and July (14.0%). Table 4 lists the average winter levels of crude protein of *Kochia* compared to other range plants. Forage kochia tends to green up earlier in the spring than many other range plants. Crude protein levels in new spring growth ranged from 12.1% to 21.8% (Davis and Welch 1984).

Forage kochia could be an important and useful subshrub on saline, and alkaline soils of our arid and semiarid ranges in the western United States. It grows well on a wide range of soil textural classes, sandy to fine clays. It is well adapted to areas occupied by juniper-pinyon, big sagebrush, greasewood, and shadscale. It grows fairly rapidly, usually producing seed the first year. Forage kochia could provide important sources of protein

TABLE 2. In vitro digestibility of winter range forages.

Winter forage	Dry matter digestibility/%	Range	Reference*
Aspen	57.4		1
Big sagebrush	57.3	(49.9–67.0)	2, 3, 4, 5, 6, 7, 10
Bud sagebrush	57.0		8
Woods rose	54.5		1
Sand dropseed grass	53.2		8
Black sagebrush	53.7	(53.1–54.0)	3, 8, 14
Rose hips	51.1		6
Indian ricegrass	50.0	(45.7–54.2)	8, 10
Bluestem wheatgrass	45.5		10
Curl-leaf mountain mahogany	49.1	(44.7–53.5)	4, 6
Galleta	48.2		8
Needle-and-thread	47.0		10
Bluebunch wheatgrass	45.5		10
Common winterfat	44.7		8
Rubber rabbitbrush	44.4		10
Shadscale	43.4		8
Western snowberry	41.0		1
Chokecherry	38.8	(26.3–51.3)	1, 11
Fourwing saltbush	38.3		9
Cliffrose	37.6		12
Desert bitterbrush	35.8		12
Forage kochia (P.I. 330708)	32.4		13
Forage kochia (mean)	32.2	(24.2–36.1)	13
Forage kochia (P.I. 314929)	31.0		13
Apache-plume	29.8		12
Forage kochia (P.I. 356826)	28.3		13
Gambel oak	28.1		2
Antelope bitterbrush	25.4	(19.8–30.0)	4, 6, 10, 12
True mountain mahogany	24.3	(20.0–28.5)	4, 6

*1. Dietz 1972
2. Kufeld et al. 1981
3. Sheehy 1975
4. Urness et al. 1977
5. Wallmo et al. 1977
6. Welch and Pederson 1981
7. Pederson and Welch 1982
8. Welch et al. 1983b
9. Welch and Monsen 1984
10. Ward 1971
11. Uresk and Messner 1975
12. Welch et al. 1983a
13. Welch and Davis 1984
14. Behan and Welch, in press

TABLE 3. Crude protein content of "upper" and "lower" parts of the same stems of *Kochia prostrata* through a year. Data expressed as percent of dry matter. Each data point is a mean of 13 accessions.

	Month							
Stem part	Dec.	Jan.	Feb.	Mar.	Apr.	May	July	Nov.
Upper	5.9[a]*	6.1[a]	6.1[a]	5.2[a]	5.7[a]	5.8[a]	14.4[b]	10.7[b]
Lower	8.2[a]	8.3[a]	8.7[a]	8.1[a]	9.8[a]	12.8[b]	14.0[b]	8.6[a]

*Values sharing the same letter superscript are not significantly different at the 95% level.

and carotene (Davis 1979, Davis and Welch 1984) and help introduce variety to many monoculture seedings of crested wheatgrass. Otsyina (1983) reported that during a fall grazing study sheep showed a high preference for forage kochia in shrub-grass pastures. He also reported that crude protein contents of sheep diets on forage kochia-crested wheatgrass pastures were significantly higher than sheep diets on pure crested wheatgrass (10.6% vs. 1.5%). Forage kochia shows its greatest potential for use with grass ranges in the fall and

TABLE 4. Winter crude protein content of selected range plants.

Range plant	Crude protein (% dry matter)	Range	Reference*
Crested wheatgrass (green regrowth)	15.0		16
Black sagebrush	11.7		13
Big sagebrush	11.4	(9.9–14.2)	1, 2, 3, 4, 6, 8, 9, 10, 13, 16, 19
Curlleaf mountain-mahogany	10.1	(9.6–10.6)	3, 7
Fourwing saltbush	9.6		12
Forage kochia (P.I. 330708)	8.9		20
Chokecherry	8.7	(7.6–9.9)	3, 5, 11, 17
Cliffrose	8.6	(8.4–8.8)	5, 14
Desert bitterbrush	8.5	(8.0–9.0)	3, 14
Rocky mountain juniper	8.4		1
Forage kochia (P.I. 314929)	8.4		20
Antelope bitterbrush	7.8	(6.7–9.1)	1, 3, 4, 7, 8, 9, 11, 14
True mountain-mahogany	7.8	(7.2–8.4)	1, 5, 9
Rubber rabbitbrush	7.8	(5.9–7.8)	1, 11
Shadscale	7.7		10
Forage kochia (P.I. 356826)	7.3		20
Gardner saltbush	7.2		10
Forage kochia (mean)	7.1		20
Utah juniper	6.6	(5.9–7.6)	3, 5, 7
Saskatoon serviceberry	5.9	(5.5–6.2)	3, 11
Woods rose	5.8	(5.4–6.1)	17, 18
Gambel oak	5.3	(5.1–5.4)	5, 19
Apache-plume	4.8		14
Crested wheatgrass	3.9		11
Native grass	3.6		3
Wildrye	3.2		15
Indian ricegrass	3.0	(2.5–3.5)	11, 15

*1. Dietz et al. 1962
2. Welch and McArthur 1979
3. Tueller 1979
4. Bissell et al. 1955
5. Smith 1957
6. Smith 1950
7. Smith 1952
8. Trout and Thiessen 1973
9. Medin and Anderson 1979 (data converted to dry matter basis)
10. National Academy of Sciences 1975
11. National Academy of Sciences 1958
12. Welch and Monsen 1981
13. Sheehy 1975
14. Welch et al. 1983a
15. National Academy of Sciences 1964
16. Urness et al. 1983
17. Dietz 1972
18. Welch and Andrus 1977
19. Kufeld et al. 1981
20. Davis and Welch 1984

would improve forage quantity and quality on extensive crested wheatgrass seedlings in the Intermountain West.

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